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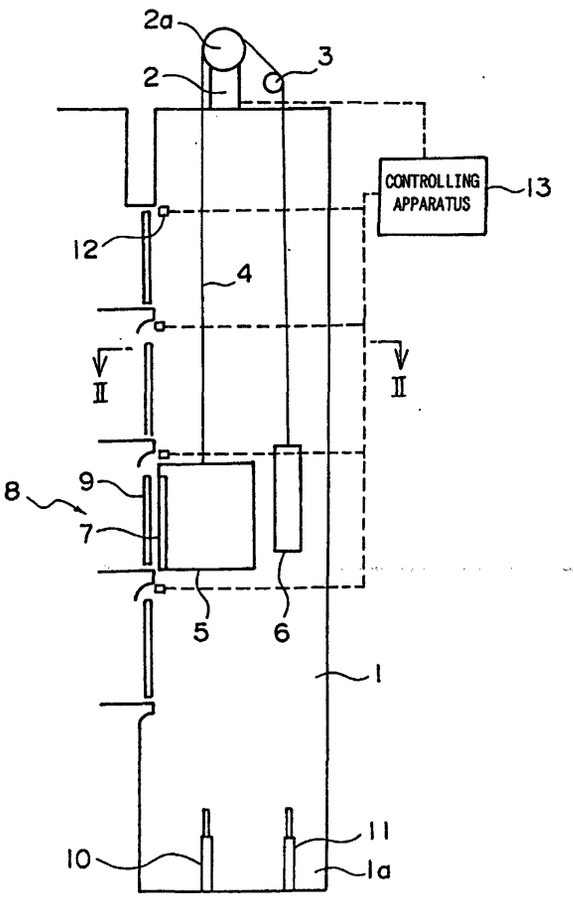
(54) **ELEVATOR DEVICE AND METHOD OF CONTROLLING THE DEVICE**

(57) In an elevator apparatus, a main rope composed of a synthetic fiber rope is used, and at least one fire detector is disposed at least at one of an area in a hoistway between the main rope and an elevator hall, and the elevator hall. When a fire detecting signal is output from the fire detector to a controlling apparatus, an emergency operation is performed by the controlling apparatus. A car is moved to a hall floor where passengers can find shelter, and then the car is moved to an upper portion in the hoistway during the emergency operation.

FIG. 1

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## Description

### TECHNICAL FIELD

**[0001]** The present invention relates to an elevator apparatus and a method for controlling same, wherein a fire can be more surely detected.

### BACKGROUND ART

**[0002]** Conventionally, a plurality of fire detectors such as smoke detectors are provided in a building in which an elevator apparatus is installed. When a fire is detected by the fire detectors, a signal is sent to a control room, and the operating mode of the elevator apparatus is switched over to an emergency operation mode by an operator in the control room. Generally, in the emergency operation mode, a car is moved to a previously designated evacuation floor.

**[0003]** Thus, in the conventional elevator apparatus, a fire is detected by fire detectors in the building side, but not normally detected at the elevator apparatus side. In this respect, it is desirable for a fire to be individually detected at the elevator apparatus side to further improve safety.

### DISCLOSURE OF THE INVENTION

**[0004]** The present invention is made to solve the problem(s) mentioned above, and an object of the present invention is to provide an elevator apparatus and a method for controlling same, wherein the occurrence of a fire can be more surely detected thereby further improving safety.

**[0005]** To this end, according to one aspect of the present invention, there is provided an elevator apparatus comprising: a hoistway; a car which moves up and down in the hoistway; a main rope for suspending the car in the hoistway; a driving machine for moving the car up and down by the main rope; and a controlling apparatus for controlling the driving machine; wherein the main rope is composed of a synthetic fiber rope; at least one fire detector is disposed at least at one of an area in the hoistway between the main rope and an elevator hall, and the elevator hall; and the controlling apparatus performs an emergency operation when a fire detecting signal from the fire detector is received.

**[0006]** According to another aspect of the present invention, there is provided an elevator apparatus comprising: a hoistway; a car which moves up and down in the hoistway; a main rope for suspending the car in the hoistway; a driving machine for moving the car up and down by the main rope; and a controlling apparatus for controlling the driving machine; wherein the elevator apparatus further comprises a fire detector including a conductive member disposed within the main rope and a detector body connected with the conductive member for detecting a temperature according to a change of electrical characteristics of the conductive member; the main rope is composed of a synthetic fiber rope, and the controlling apparatus performs an emergency operation when a fire detecting signal from the fire detector is received.

**[0007]** According to a still further aspect of the present invention, there is provided a method for controlling an elevator apparatus which comprises a hoistway, a car which moves up and down in the hoistway, a main rope for suspending the car in the hoistway, a driving machine for moving the car up and down by the main rope, and a controlling apparatus for controlling the driving machine: wherein a presence/absence of a fire is monitored at least at one of an area in the hoistway between the main rope and an elevator hall, and the elevator hall, and an emergency operation is automatically performed by the controlling apparatus when the fire is detected.

### BRIEF DESCRIPTION OF THE DRAWINGS

**[0008]**

Fig. 1 is a structural view showing an elevator apparatus according to a first embodiment of the present invention;

Fig. 2 is a cross-sectional view taken along the line II-II in Fig. 1;

Fig. 3 is a perspective view showing a construction of the main rope in Fig. 1;

Fig. 4 is a structural view showing a fire detector according to a second embodiment of the present invention;

Fig. 5 is a structural view showing a fire detector according to a third embodiment of the present invention;

Fig. 6 is a structural view showing a fire detector according to a fourth embodiment of the present invention; and

Fig. 7 is a structural view showing an elevator apparatus according to a fifth embodiment of the present invention.

### BEST MODE FOR CARRYING OUT THE INVENTION

**[0009]** Preferred embodiments of the present invention will be described below with reference to the accompanying drawings. First Embodiment

**[0010]** Fig. 1 is a structural view showing an elevator apparatus according to a first embodiment of the present invention, and Fig. 2 is a cross-sectional view taken along the line II-II in Fig. 1. In the figures, a driving machine (hoisting machine) 2 having a driving sheave 2a is installed at an upper portion of a hoistway 1. A main rope 4 made of synthetic fiber rope is wound around the driving sheave 2a and a deflector sheave 3.

**[0011]** A car 5 is suspended at one end of the main rope 4. A counterweight 6 is suspended at the other end of the main rope 4. Car doors 7 are provided at the front

of the car 5. Landing doors 9 are provided at every elevator hall 8. A car buffer 10 for receiving the car 5 and a counterweight buffer 11 for receiving the counterweight 6 are installed at a bottom portion (pit) 1a of the hoistway 1.

**[0012]** A plurality of fire detectors 12 for detecting occurrence of a fire are disposed at an area in the hoistway 1 between the main rope 4 and the elevator halls 8. These fire detectors 12 are installed on hoistway walls 1b opposing both sides of the car 5 at every floor to individually detect a fire at every elevator hall 8. Further, a thermal sensing device which detects a fire when a previously set ambient temperature is reached and a smoke detector which detects smoke generated by the fire are used as the fire detector 12.

**[0013]** In the case of using thermal sensing devices as fire detectors 12, the temperature is set, for example, at or higher than 50°C by allowing for 40°C that is an irregular temperature higher than a normal temperature in the hoistway 1. However, since there is a fear that the main rope 4 made of synthetic fiber rope is broken, for example, at 400°C to 500°C, there is necessity to set the set temperature lower than the breaking temperature of the main rope 4.

**[0014]** All the fire detectors 12 are connected to a controlling apparatus 13 which controls the driving machine 2. The controlling apparatus 13 performs an emergency operation by receiving a fire detecting signal from at least one of the fire detectors 12.

**[0015]** Fig. 3 is a perspective view showing a construction of the main rope 4 in Fig. 1. In the figure, an inner strand layer 24 having a plurality of inner strands 22 and filling strands 23 disposed in gaps between the inner strands 22 is disposed around a core rope 21. Each inner strand 22 is composed of a plurality of aramid fibers and an impregnating agent such as polyurethane or the like. The filling strands 23 are composed of, for example, polyamide.

**[0016]** An outer strand layer 26 having a plurality of outer strands 25 is disposed around the outer periphery of the inner strand layer 24. Each outer strand 25 is composed of a plurality of aramid fibers and an impregnating agent such as polyurethane or the like just as in the inner strands 22.

**[0017]** A friction reducing covering layer 27 for preventing the strands 22 and 25 from abrasion resulting from friction between strands 22 and 25 at sheaves such as the driving sheave 2a or the like is disposed between the inner strand layer 24 and the outer strand layer 26. Further, a protective covering layer 28 is disposed around the outer periphery of the outer strand layer 26. This synthetic fiber rope has the characteristic of breaking at lower temperatures, for example, 400°C to 500°C, than steel rope.

**[0018]** The car 5 and the counterweight 6 are suspended in the hoistway 1 by a plurality of main ropes 4 each of which has the above described construction. Further, in the main ropes 4, load is transmitted only by the strands 22 and 25.

**[0019]** In the elevator apparatus constructed as described above, when a fire occurs at the building side and it is detected by at least one of the fire detectors 12, the fire detecting signal is output from the fire detector 12 to the controlling apparatus 13. When the fire detecting signal is input to the controlling apparatus 13, an operating mode is automatically switched over from a normal mode to an emergency operation mode.

**[0020]** In the emergency operation, the car 5 is moved to a previously designated landing floor (evacuation floor) and passengers in the car 5 get off the car 5. At this time, if a fire is individually monitored at every elevator hall 8, it is also possible for the car 5 to be moved to other landing floors while avoiding landing floors where a fire is detected.

**[0021]** After the passengers evacuate from the car 5, the car 5 is moved to the upper portion in the hoistway 1, where there is, for example, an uppermost floor or a further upper portion. At this time, the counterweight 6 is moved to the lower portion in the hoistway 1.

**[0022]** In such an elevator apparatus, since the fire detectors 12 are disposed at the area in the hoistway 1 between the main rope 4 and the elevator halls 8 and emergency operation is automatically performed by the controlling apparatus 13 when a fire is detected, the occurrence of a fire can be more surely detected thereby further improving safety. Also, since the fire detectors 12 are disposed at the elevator hall 8 side in relation to the main rope 4, emergency operations can be more surely performed before the main rope 4 is broken by a fire.

**[0023]** In the unlikely event that a fire spreads in the hoistway 1 and the main rope 4 is broken after the emergency operation, since the counterweight 6 is located at the lower portion in the hoistway 1, the falling distance of the counterweight 6 is shortened, and impact by the falling counterweight is sufficiently buffered by the counterweight buffer 11. On the other hand, although the car 5 is located at the upper portion in the hoistway 1, it is prevented from falling by a safety device (not shown).

**[0024]** It should be noted that, while, in the first embodiment, fires are individually monitored at every elevator hall 8, it is also possible to dispose the fire detectors 12 so as to detect a fire at each of a plurality of detection blocks each of which includes a plurality of elevator halls 8. Because of this, in a case where there is a large number of elevator halls 8, such as in a high-rise building or the like, the number of fire detectors 12 can be reduced.

Second Embodiment

**[0025]** Next, Fig. 4 is a structural view showing a fire detector according to a second embodiment of the present invention. In the figure, a thermal sensing device 31 as a fire detector has a conductive member 32 and a detector body 33 connected with the conductive

member 32 for detecting temperature according to changes in electrical characteristics that is, for example, the electric resistance value of the conductive member 32. The conductive member 32 is disposed continuously in the hoistway 1 from an uppermost landing floor to a lowermost landing floor. The detector body 33 is disposed at the bottom portion 1a of the hoistway 1, and connected to the controlling apparatus 13 described in the first embodiment. For example, steel wire, carbon wire or the like is used as the conductive member 32. The other constructions are the same as in the first embodiment.

**[0026]** In such a thermal sensing device 31, when the temperature in the hoistway 1 is increased by a fire, the electric characteristics of the conductive member 32 are changed. This change is monitored by the detector body 33, and when a previously set temperature (for example, 50°C) has been reached, the detector body 33 outputs a fire detecting signal and the emergency operation is performed by the controlling apparatus 13 (Fig. 1). The contents of the emergency operation are the same as in the first embodiment.

**[0027]** Thus, the occurrence of a fire can be more surely detected by the thermal sensing device 31 using changes in the electric characteristics of the conductive member 32, thereby further improving safety. Also, changes in temperature of the whole hoistway 1 can be monitored by this simple construction.

**[0028]** It should be noted that, while, in the second embodiment, one conductive member 32 is disposed in the whole of the hoistway 1, it is also possible to divide the hoistway 1 into a plurality of blocks and dispose a conductive member 32 at every block such as in the case of, for example, a high-rise building.

Third Embodiment

**[0029]** Next, Fig. 5 is a structural view showing a fire detector according to a third embodiment of the present invention. In the figure, a thermal sensing device 35 as a fire detector has a detecting element 36, a detector body 37 for detecting a temperature according to expansion and contraction of the detecting element 36, and a weight 38 suspended at the lower end portion of the detecting element 36. The weight 38 is provided with an operating portion 38a. The detector body 37 is provided with a switch 37a to be operated by the operating portion 38a.

**[0030]** The detecting element 36 is disposed continuously in the hoistway 1 from an uppermost landing floor to a lowermost landing floor. The detector body 37 is installed at the bottom portion 1a of the hoistway 1. The detecting element 36 is composed of, for example, a metal wire or a resin wire. The other constructions are the same as in the first embodiment.

**[0031]** In such a thermal sensing device 35, when the temperature in the hoistway 1 is increased by a fire, the detecting element 36 expands and the weight 38 is lowered. When a previously set temperature (for example, 50°C) has been reached, the switch 37a is operated by the operating portion 38a, a fire detecting signal is output from the detector body 37, and the emergency operation is performed by the controlling apparatus 13 (Fig. 1). The contents of the emergency operation are the same as in the first embodiment.

**[0032]** Thus, the occurrence of a fire can be more surely detected by the thermal sensing device 35 using the thermal expansion of the detecting element 36, thereby further improving safety. Also, changes in the temperature of the whole hoistway 1 can be monitored by this simple construction.

**[0033]** It should be noted that, while, in the third embodiment, one detecting element 36 is disposed in the whole of the hoistway 1, it is also possible to divide the hoistway 1 into a plurality of blocks, and dispose the detecting element 36 at every block and the weight 38 and the detector body 37 are disposed for each of the detecting elements 36 such as in the case, for example, a high-rise building.

**[0034]** Further, while the thermal sensing device 35 is shown detecting the thermal expansion of the detecting element 36 in the third embodiment, it is also possible that a detecting element which fuses when a temperature previously set has been reached is used, and a detector body mechanically or electrically detects the fusion of the detecting element to output a fire detecting signal. Fourth Embodiment

**[0035]** Next, Fig. 6 is a structural view showing a fire detector according to a fourth embodiment of the present invention. In the figure, a jamb 41 is fixed to both side portions and an upper portion of a hall entrance 8a of the elevator hall 8 of every floor. Hall buttons 42 and a hall indicator 43 are provided on the jamb 41. A fire detector 44 which is constituted by a smoke detector or a thermal sensing device is installed at the upper portion of the jamb 41. The other constructions are the same as in the first embodiment.

**[0036]** Thus, the occurrence of a fire can be more surely detected even if the fire detector 44 is disposed at the elevator hall 8, thereby further improving safety. Also, there is no necessity to add any new processing to the building side because the fire detector 44 is disposed at the jamb 41 which is a component of the elevator apparatus side. Further, since the fire detector 44 is disposed at the upper portion of the jamb 41, a fire can be detected at an earlier stage.

Fifth Embodiment

**[0037]** Next, Fig. 7 is a structural view showing an elevator apparatus according to a fifth embodiment of the present invention. In the figure, a fire detector 51 includes a conductive member 52 disposed within the main rope 4 and a detector body 53 connected with the conductive member 52 for detecting a temperature according to a change of electrical characteristics such as,

for example, electric resistance of the conductive member 52.

**[0038]** In such a fire detector 51, when the temperature in the hoistway 1 is increased by a fire, the electric characteristics of the conductive member 52 are changed. This change is monitored by the detector body 53, and when a previously set temperature (for example, 50°C) has been reached, an emergency operation is performed by the controlling apparatus 13 (Fig. 1). The contents of the emergency operation are the same as in the first embodiment.

**[0039]** Thus, the occurrence of a fire can be more surely detected by the fire detector 51 in which the conductive member 52 is disposed within the main rope 4, thereby further improving safety.

**[0040]** It should be noted that the fire detector is not limited to the above described types. Further, although it is possible to use only one type of the above described fire detectors, a plurality of the fire detector types may also be used in combination. Furthermore, the fire detector may be disposed at the area between the main rope 4 and the elevator hall 8 in the hoistway 1 and/or the elevator hall 8.

## Claims

**1.** An elevator apparatus comprising:

a hoistway;
a car which moves up and down in said hoistway;
a main rope for suspending said car in said hoistway;
a driving machine for moving said car up and down by said main rope; and
a controlling apparatus for controlling said driving machine;
wherein said main rope is composed of a synthetic fiber rope;
at least one fire detector is disposed at least at one of an area in said hoistway between said main rope and an elevator hall, and said elevator hall; and
said controlling apparatus performs an emergency operation when a fire detecting signal from said fire detector is received.

**2.** An elevator apparatus according to claim 1, wherein said fire detector is a smoke detector.

**3.** An elevator apparatus according to claim 1, wherein said fire detector is a thermal sensing device.

**4.** An elevator apparatus according to claim 3, wherein said thermal sensing device has a conductive member and a detector body connected with said conductive member for detecting a temperature according to a change of electrical characteristics of said conductive member.

**5.** An elevator apparatus according to claim 4, wherein said conductive member is disposed continuously in said hoistway from an uppermost landing floor to a lowermost landing floor.

**6.** An elevator apparatus according to claim 3, wherein said thermal sensing device has a detecting element and a detector body for detecting a temperature according to expansion and contraction of said detecting element.

**7.** An elevator apparatus according to claim 6, wherein said detecting element is disposed continuously in said hoistway from an uppermost landing floor to a lowermost landing floor.

**8.** An elevator apparatus according to claim 1, wherein said fire detector has a detecting element which fuses at a lower temperature than a temperature where said main rope breaks, and a detector body for detecting the fusing of said detecting element.

**9.** An elevator apparatus according to claim 1, wherein said fire detector is disposed to detect a fire individually at each elevator hall.

**10.** An elevator apparatus according to claim 1, wherein said fire detector is disposed to detect a fire individually at each of a plurality of detecting blocks, each of which includes a plurality of said elevator halls.

**11.** An elevator apparatus according to claim 1, wherein a jamb is provided at said elevator hall, and said fire detector is disposed at an upper portion of said jamb.

**12.** An elevator apparatus comprising:

a hoistway;
a car which moves up and down in said hoistway;
a main rope for suspending said car in said hoistway;
a driving machine for moving said car up and down by said main rope; and
a controlling apparatus for controlling said driving machine;
wherein said elevator apparatus further comprises a fire detector including a conductive member disposed within said main rope and a detector body connected with said conductive member for detecting a temperature according to a change of electrical characteristics of said conductive member;
said main rope is composed of a synthetic fiber

rope, and said controlling apparatus performs an emergency operation when a fire detecting signal from said fire detector is received.

**13.** A method for controlling an elevator apparatus which comprises a hoistway, a car which moves up and down in said hoistway, a main rope for suspending said car in said hoistway, a driving machine for moving said car up and down by said main rope, and a controlling apparatus for controlling said driving machine:

wherein a presence/absence of a fire is monitored at least at one of an area in said hoistway between said main rope and an elevator hall, and said elevator hall, and an emergency operation is automatically performed by said controlling apparatus when the fire is detected.

**14.** A method for controlling an elevator apparatus, according to claim 13, wherein said car is moved to a specific hall floor previously designated during said emergency operation.

**15.** A method for controlling an elevator apparatus, according to claim 13, wherein a fire is monitored individually at each elevator hall, and said car is moved to a hall floor while averting hall floors where a fire has been detected during said emergency operation.

**16.** A method for controlling an elevator apparatus, according to claim 13, wherein said elevator apparatus is further equipped with a counterweight suspended by said main rope, an emergency stop device is provided on said car, and said car is moved to a hall floor where passengers can fined shelter, and then said car is moved to an upper portion in said hoistway during said emergency operation.

FIG. 1

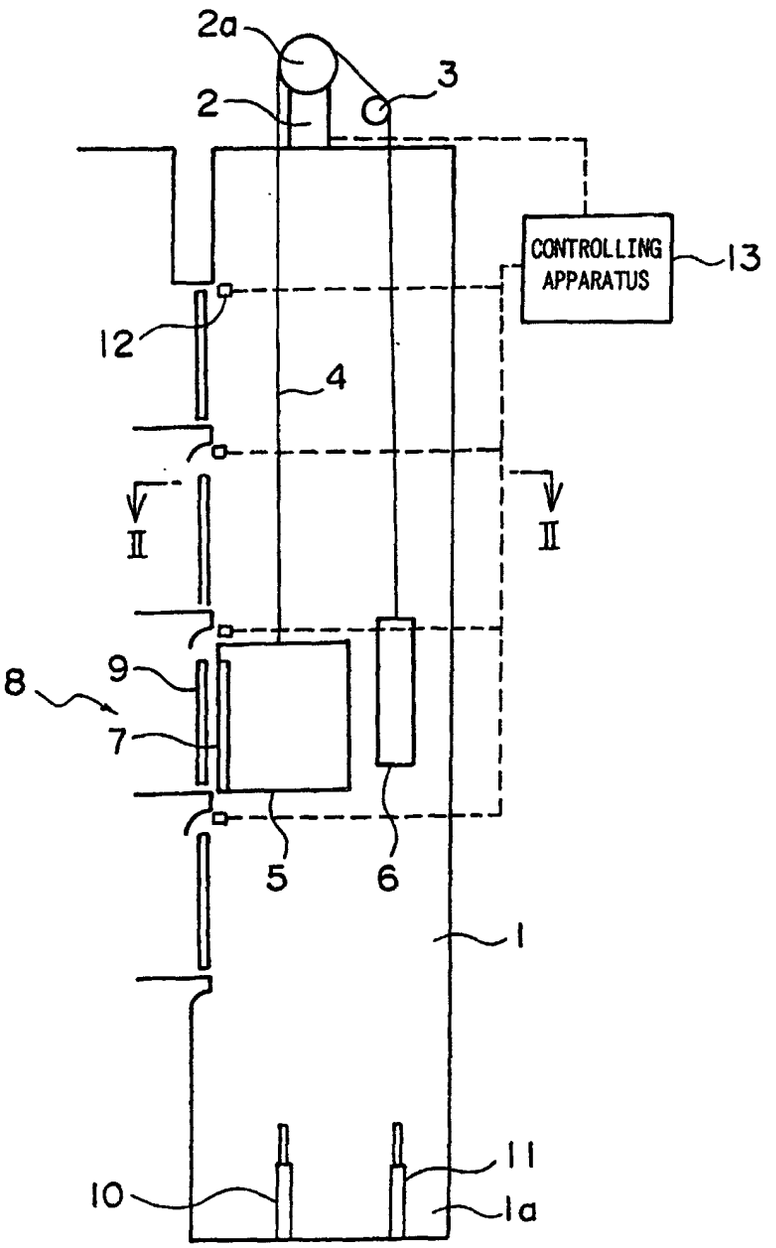


FIG. 2

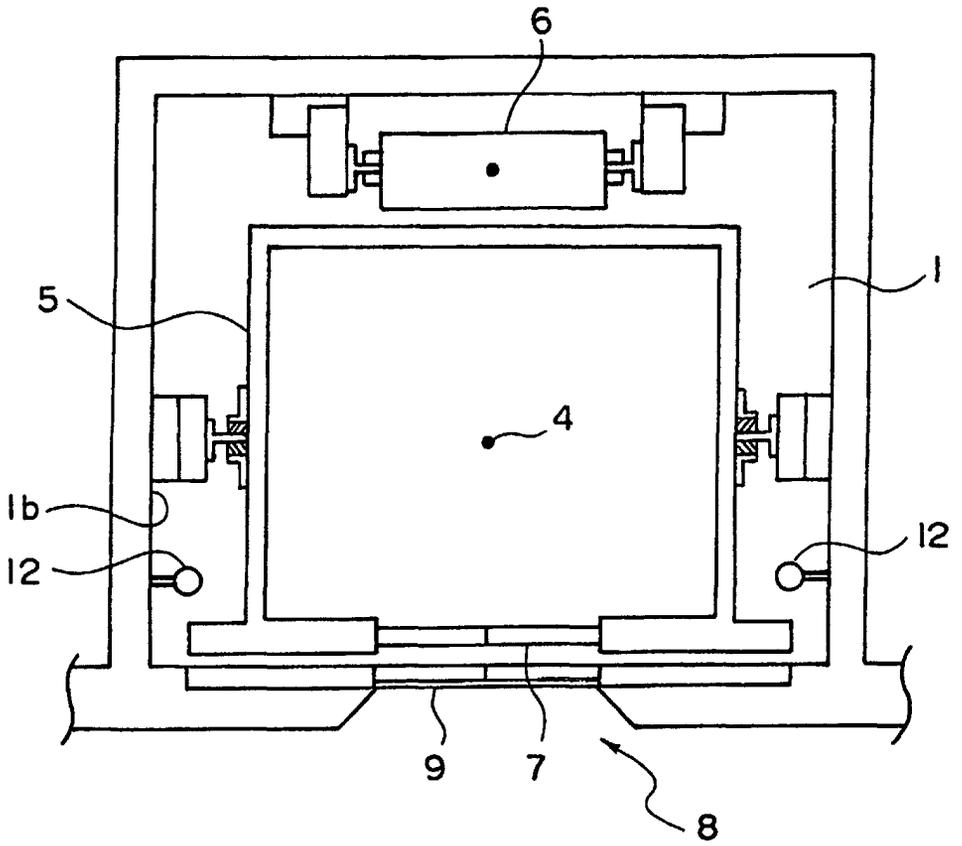



FIG. 3

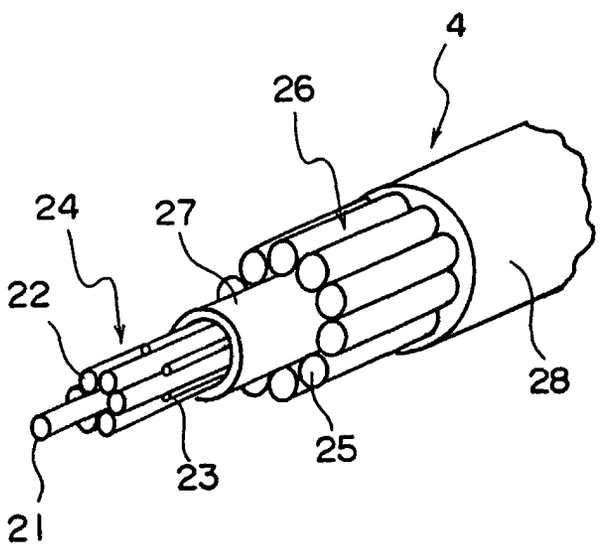


FIG. 4

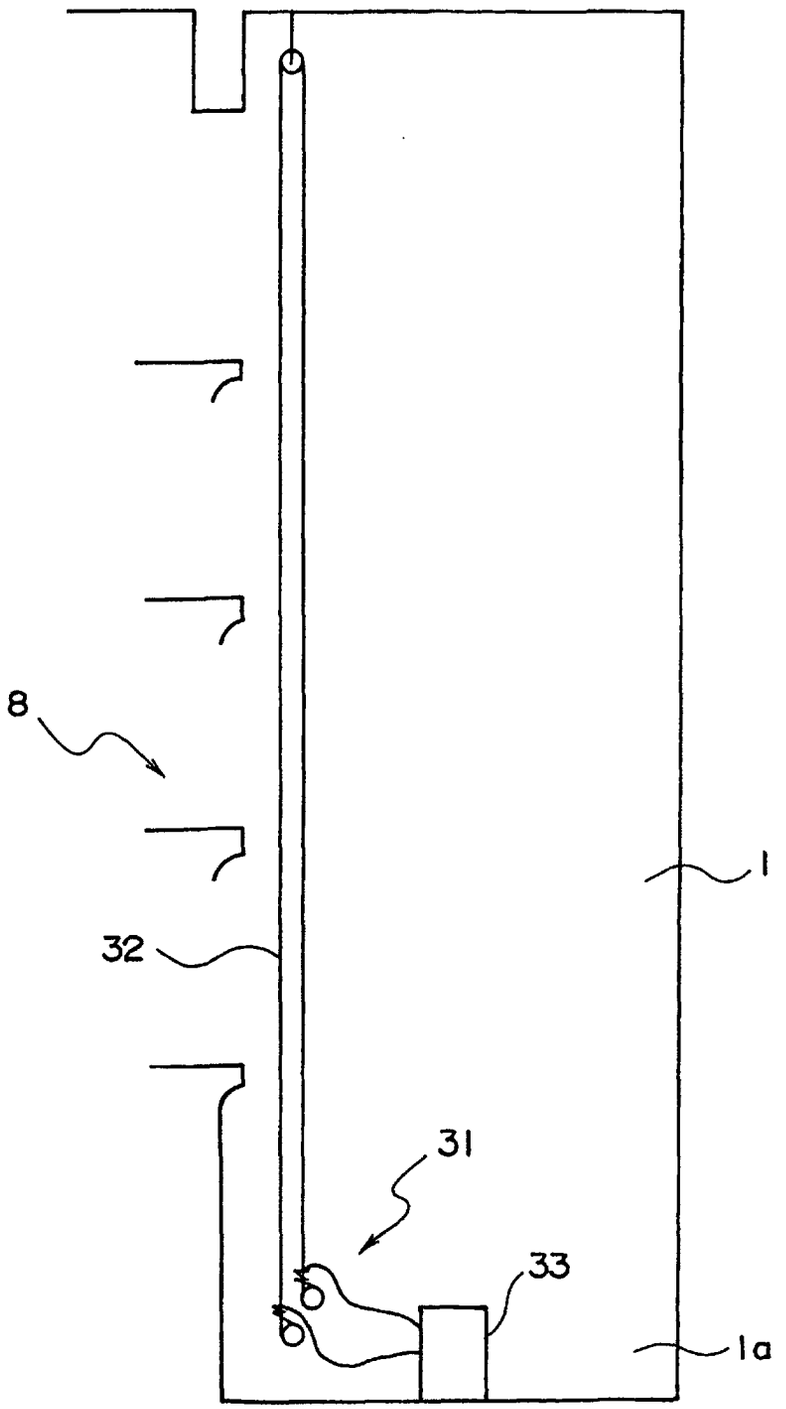


FIG. 5

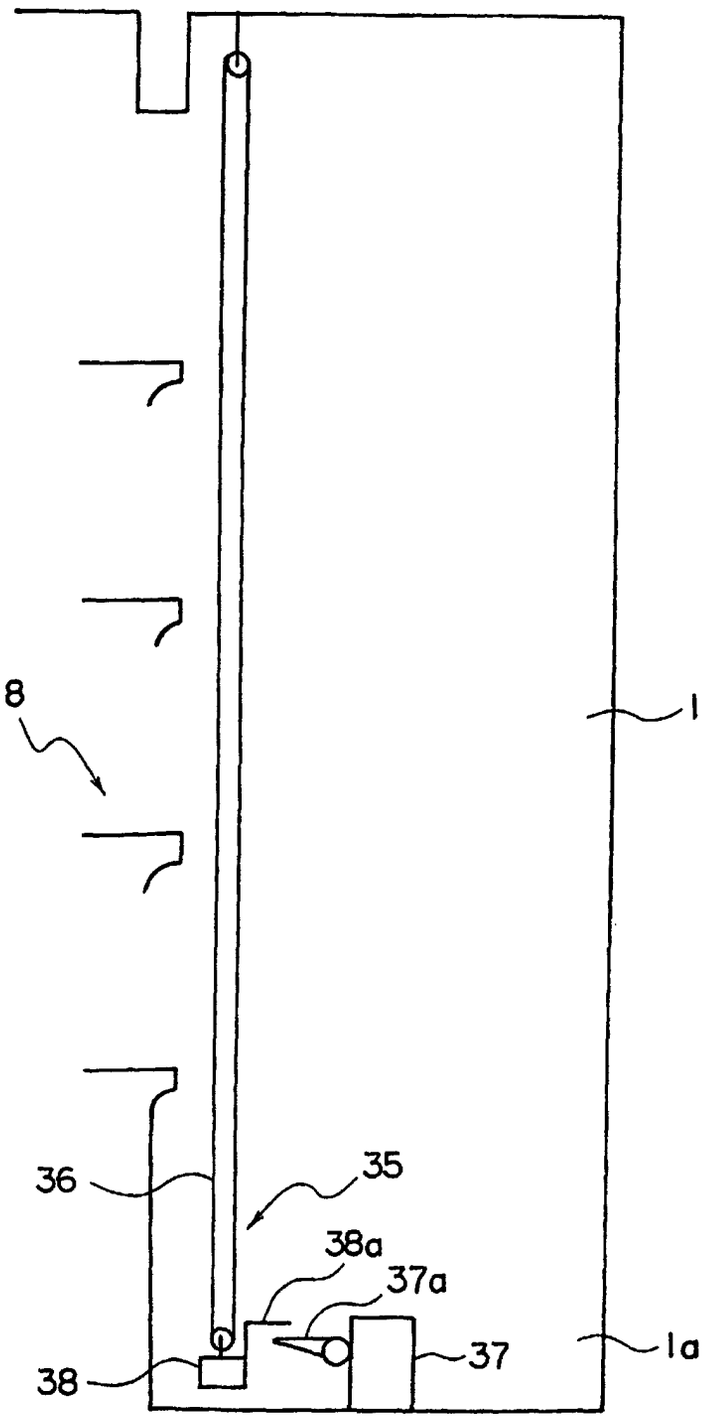


FIG. 6

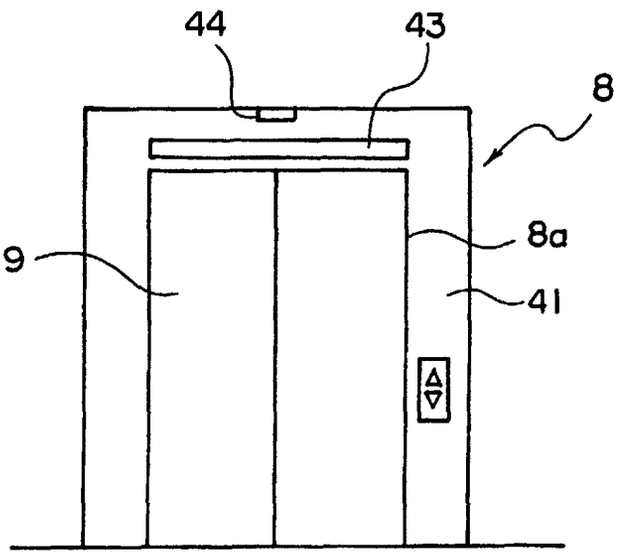
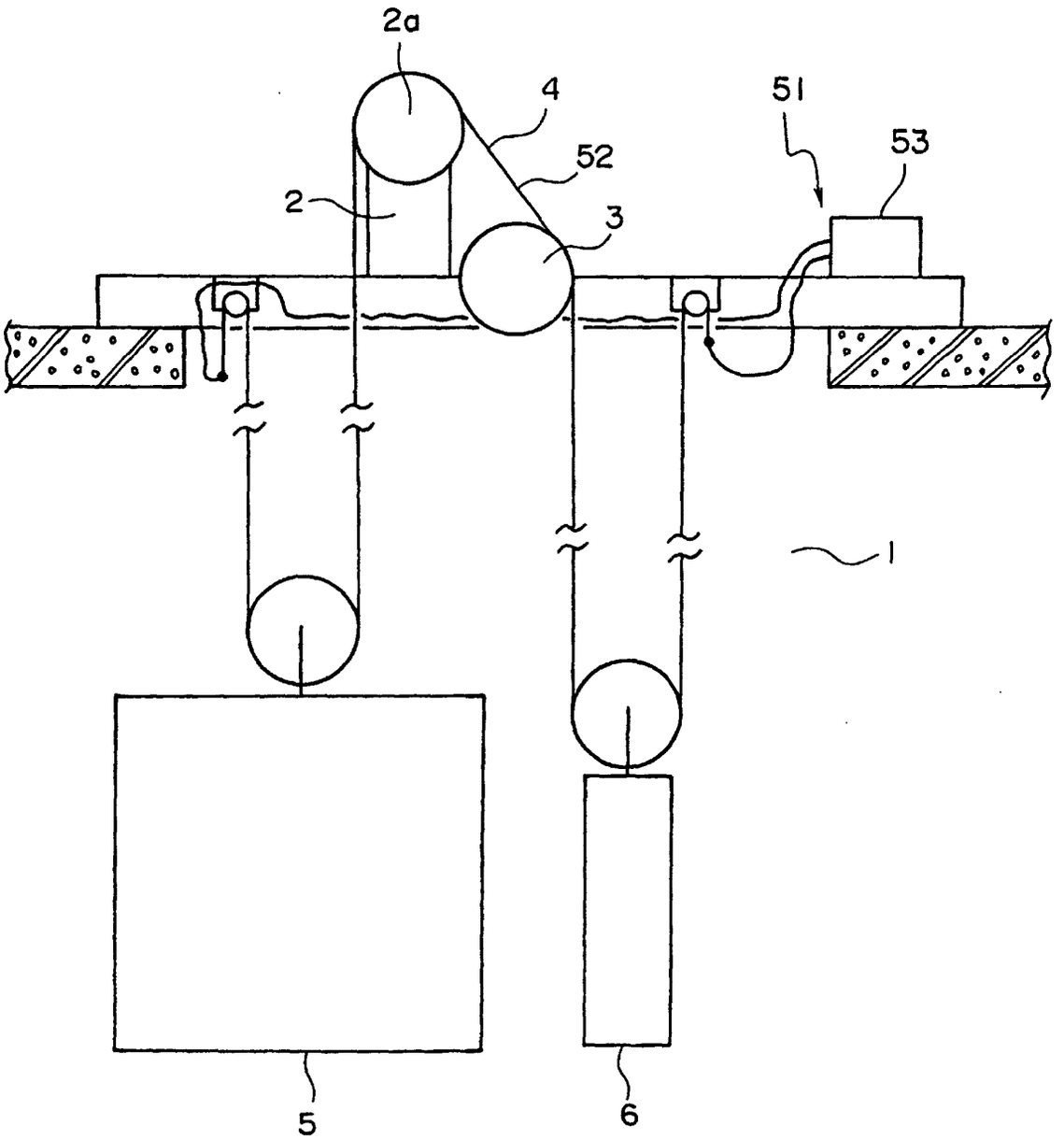


FIG. 7



# INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP00/05109

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl[7] B66B 5/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl[7] B66B 1/00-B66B 7/12, D07B 1/00-D07B 1/22

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2001
Kokai Jitsuyo Shinan Koho 1971-2001 Toroku Jitsuyo Shinan Koho 1994-2001

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| Y | JP, 62-171880, A (Mitsubishi Electric Corporation), 28 July, 1987 (28.07.87), (Family: none) | 1-5,8-9,11-16 |
| A | JP, 53-121678, A (Mitsubishi Electric Corporation), 24 October, 1978 (24.10.78), (Family: none) | 1-2 |
| A | JP, 4-358680, A (Hitachi Building System Service Co., Ltd.), 11 December, 1992 (11.12.92), (Family: none) | 1,3 |
| Y<br>A | EP, 1022376, A1 (Inventio AG), 26 July, 2000 (26.07.00), & JP, 2000-220084, A & CA, 2297378, A1 & CN, 1270252, A | 1-5,8-9,11-16<br>6-7 |
| A | JP, 7-247076, A (Toshiba Corporation), 26 September, 1995 (26.09.95), (Family: none) | 10-11 |

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| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 06 March, 2001 (06.03.01) | 21 March, 2001 (21.03.01) |
| Name and mailing address of the ISA/ Japanese Patent Office | Authorized officer |
| Facsimile No. | Telephone No. |

Form PCT/ISA/210 (second sheet) (July 1992)

## INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP00/05109

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| Y | JP, 10-87211, A (Hitachi, Ltd.), 07 April, 1998 (07.04.98), (Family: none) | 14-16 |

Form PCT/ISA/210 (continuation of second sheet) (July 1992)